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ABSTRACT

A discrepancy exists between children's ability to compute and their ability to solve mathematical word problems. The literature suggests a variety of methods that have been attempted to improve this skill with varying success. The utilization of manipulatives, visualization, illustration, and emphasis on improving listening skills all were incorporated into this practicum. The children had the opportunity to write their own word problems. At no time were students taught to rely on key words but rather to reason. All problems were read to the children. They were not permitted to read along with the teacher. The percentage of children improving problem solving skills rose favorably from the pre-test to the post-test. (The document includes the purpose of the project, a brief literature review, a summary of the methods used, results, and recommendations. Appendices include the pre-test and post-test, and student math score data.) (Author/CW)

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A DESIGN TO IMPROVE CHILDREN'S COMPETENCIES IN SOLVING MATHEMATICAL WORD PROBLEMS

by
HELENE ZIMMERMAN

A Practicum Report
submitted to the Faculty of the Center for the Advancement of Education of Nova University in partial fulfillment of the requirements for the degree of Master of Science.

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Running head: SOLVING WORD PROBLEMS

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Authorship Statement

I hereby testify that this paper and the work it reports are entirely my own. Where it has been necessary to draw from the work of others, published or unpublished, I have acknowledged such work in accordance with accepted scholarly and editorial practice. I give this testimony freely, out of respect for the scholarship of other workers in the field and in the hope that my work, presented here, will earn similar respect.

Signed: Helen Zimmerman

Abstract

A Design to Improve Children's Competencies in Solving Mathematical Word Problems.
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Descriptors: Solving Word Problems/Math Application/ Math Competencies/In Word Problems/Visualizing Math/

A discrepancy exists between children's ability to compute and their ability to solve mathematical word problems. The literature suggests a variety of methods that have been attempted to improve this skill with varying success. The utilization of manipulatives, visualization, illustration and emphasis on improving listening skills all were incorporated in this practicum. The children had the opportunity to write their own word problems. At no time were students taught to rely on key words but rather to reason. All problems were read to the children. They were not permitted to read along with the teacher. The percentage of children improving problem solving skills rose favorably from the pre to the post test. Appendices include pre and post tests and student math score data.

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Practicum Title A Design To Improve Children's Competencies In Solving Mathematical Word Problems.

Student's Name Helene Zimmerman

Program Site Pinecrest Elementary Date April 7, 1989

Observer's Name Francine Nadler Francine Nadler
(please print---------and sign)

Observer's position Teacher Phone # 667-5579

Observer's comment on impact of the project (handwritten):

Problem solving is an integral part of the academic program and one which can be practiced and improved. Materials were created, prepared for distribution, and utilized in Mrs. Zimmerman's class. In addition, vital parts of her program were shared by staff members

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CHAPTER I

Purpose

The community surrounding this elementary school is composed of upper middle class professional and business people who take an above average interest in their children's elementary education. Volunteers gave over 5,000 hours to the school in the 1987-1988 school year. The P.T.A. is very active and has donated many thousands of dollars to the school over the years raised by numerous fund raising efforts. In 1986 when national recognition was first given to elementary schools for special achievements, this elementary school was selected for special recognition.

The school is on an 11 acre pine tree covered site, made up of six one-story permanent buildings and five portable classrooms. The permanent buildings house classrooms, a media center, including a computer lab, a cafeteria and offices.

There are over 900 students in grades kindergarten through six. The instructional staff is made up of 25 classroom teachers, one guidance counselor, one librarian, and teachers' aides. Parents contribute an average of $100 per family per year thereby enabling the administration to hire more classroom aides and

further lower the ratio of students to instructor.

The student population is composed of 76 percent White non-Hispanic, five percent Black non-Hispanic, 16 percent Hispanic, and three percent Asian and American Indian. Four and nine-tenths percent of the students have limited English proficiency. Twenty-three students receive compensatory education instruction, a program to help students with below average reading and mathematics scores on standardized tests. Three and six-tenths percent of the students receive free or reduced priced lunch. The attendance averages 95.7 percent. There were no out of school suspensions and no student received corporal punishment during the 1987-88 school year. After school care is not provided at the school, but many students go to before and after school care at a church directly across the street.

The school has been designated a "Quiip School," Quality Instruction Incentive Program, for the past two consecutive years. The Quiip program monetarily rewards faculty and staff at schools who propose and implement a program to improve and/or enrich by measurable means some aspect of education at the school. Last year this writer served on the committee, whose objective was to raise reading comprehension scores through increasing leisure reading. The objective was

successfully met.

This writer has been on the faculty of five elementary schools in the 10 years spent in the public school system and has taught every elementary level, with the exception of fifth. These school populations have covered a diversified spectrum of socioeconomic makeup. This writer has served on Quiip committees in another school and a committee who worked to raise scores on the State Student Assessment Test in a deficient school. This researcher taught Chapter I first grade for two years and then was asked to leave the classroom and be the Chapter I facilitator, to help other classroom teachers. This offer was declined, the preference being to remain in the classroom. This writer has served as a peer teacher for three years and has been the grade level chairperson for two years.

Mathematical proficiency in application does not correlate with higher scores in mathematical computation at the second grade level. This is a problem evidenced by scores on the 1986 and 1987 Stanford Achievement Test at the practicum school (see Appendix A). In 1979 the National Assessment of Education Progress indicated that the primary source of difficulty in mathematical problem solving was the inability of the child to choose the correct operation. The

study was based on 70,000 nine to 13 year olds and showed that although arithmetic computational instruction is adequate, students are not taught to apply these skills to problem solving (Talton, 1985). This problem is further evidenced by Stanford Achievement Test scores from other schools as shown on the following page. The researcher's school site may not have a problem of any great magnitude as compared with other schools in the county (see Appendix B).

Generally after students learn to perform a computational operation, they practice solving word problems with the same operation. Many pages in the typical text book will have computational lessons, drill and practice, with a few pages devoted to application at the end of the chapter. These word problems require the same operation as the computation in the chapter. Further complicating the problem, students are taught key words to enable them to choose the correct operation.

Paper and pencil teaching may be inappropriate at a young age.

> Children differ in their cognitive capacity to function with quantitative verbal problems. Second, children who differ in cognitive processing capacity, also differ in the strategies they use to solve the same verbal problems and differ in their success in finding correct answers. Third, children's decisions to use

> taught algorithms to solve these problems appear to depend more on semantic structure of the problems than on either instruction or cognitive capacity (Romberg & Collis, 1985, p. 380).

Children at the second grade level possess various reading ability levels, at times two years below the second grade level of the text. Frustration begins at the point these students look at the printed words and are required to change them to numerical representations. At this point if a teacher is to continue with the text book lesson or assess the students with the correlating text book chapter assessment, one on one instruction is required. The lesson then becomes a reading lesson not a mathematical application lesson, with expected frustration.

The Stanford Achievement Test is administered in the spring. The second grade student is given an unfamiliar challenge, because the application problems are read to the student, who does not have a copy to silently read as the teacher reads. The student only has the choice of four answers to look at. Now the demands are made on the student's listening skills, which are known to be deficient at every age level. Unless the student has been trained to listen for the question, record the numbers and decide on and perform an operation on scratch paper before he chooses an

answer, he often takes a guess or relies on what he remembers the teacher read.

Problem solving requires visualizing and an imagination. Today's students watch television. They've not imagined how someone looks as they listen to the radio. The classics aren't read but watched on a video. There's no need to imagine. There is no need to create games, to think of ways to entertain one's self when all activities are planned. Children don't go to the corner store alone. They don't deal with how much candy they can buy with their quarter. They shop with adults who write checks and use credit cards. Teaching methods must address these issues if students are to solve problems.

For some students the problem of passing a third grade State Assessment Test becomes evident in schools with an even wider discrepancy between computation and application scores.

In discussion with the Department Chairperson in charge of testing at one of these schools, the writer was told that although math scores are combined on this test, an analysis of math items indicates the deficient area is in word problems.

This researcher discussed this practicum with the administrator of the targeted school. She stated that

a unique situation exists here as compared with other elementary schools. Here, only at the second grade level are math application scores significantly lower than computation scores. In addition these scores are coupled with high scores in mathematics concepts.

Although this researcher worked with students whose scores in second grade do not have a huge difference between mathematical computation and application, it is considered a problem by the administration, parents and teachers.

This researcher sought to raise test scores of math application by a minimum of 10 percentage points from the pretest to the post test. It was the researcher's goal that knowledge gained can also be used to raise standardized test math application scores in schools where the problem is even greater than at the targeted school.

There are four objectives of this practicum. Three of the objectives were evaluated formatively. Summative evaluation was a post test, which duplicates the original pretest. The first objective was tested by teacher observation as it required use of manipulatives and visualization. According to research, these two components are not taught with enough frequency, resulting in students' deficits. The writer observed

students as they worked out the problems and recorded students' results on a problem by problem checklist which indicates number of students with correct answers on a scale of few, many or most.

Objective I

After two weeks of instruction, 80 percent of the students participating in problem solving lessons three times a week will solve word problems with 100 percent accuracy using concrete objects on a teacher made test read to the students.

Objective II

After four weeks of instruction, 70 percent of students participating in problem solving lessons three times a week will score 60 percent or above on a teacher made test requiring students to pictorially represent story problems read to them.

Objective III

After eight weeks of instruction, 80 percent of the students participating in problem solving lessons three times a week will solve word problems by substituting symbols for concrete objects with 80 percent accuracy on a teacher made test read to the students.

Objective IV

After 10 weeks of instruction, 80 percent of the students participating in problem solving lessons three

times a week will score 80 percent or above on a post test. Word problems taken from the Metropolitan Achievement Test, the Spring Achievement Test, and teacher written problems will be read to the students.

CHAPTER II

Research and Solution Strategy

Teaching children to solve word problems and to master this skill has long been a challenge of educators. Typically a student has mastered computational skills and at times has adequate mastery of comprehension skills, but to date mastery of word problems is as yet unattainable. This researcher looked for clues and found none that would guide her on a definite course of action. Many researchers wrote of partial success, of ideas and methods that have had partial positive results, but none with the answer to the problem. This writer endeavored to implement a program based on a combination of methods reviewed in the literature, discussions with colleagues, and personal experiences. The evaluation of the implementation was ongoing to enable this researcher to attempt different strategies when deemed appropriate.

Student achievement was monitored over three years at a study conducted at the Wisconsin Center for Education research. The study focused on acquisition of problem solving skills by second graders. Ten performance objectives were taught with unit tests following each, given in the form of pencil-paper group tests.

In addition, individual student interviews were conducted to determine solution strategies, types of errors, and correctness of answers. Modeling procedures were suggested when appropriate. The study was conducted with 180 students in three schools. In the second year, one school with 60 students dropped out. Teachers were observed daily. The students were taught to symbolize verbal facts and then decide on addition or subtraction operations. All items on tests were read to the children, after which the correct number sentence was selected. The study cited a marked improvement in problem solving and sentence writing, with numbers zero - 99, without regrouping. However, there was no mastery of problem solving skills (Buchanan, 1982). This researcher used a sampling of problems from the (Spring) Achievement Monitoring Test developed by this study, on the practicum pre and post tests.

In a paper presented at the Annual Meeting of the American Educational Research Association, symbolic representation of addition and subtraction verbal problems was discussed. Children develop informal techniques for solving word problems before they come to school, but then they lose their ability in school. Educators need to build on their early insights. It appears that before children can read, they can work

out math problems with concrete objects. With simple problems representation may not be necessary. The only requirement is a recall of facts. The paper cited studies conducted in teaching from concrete to number sentences and finally making up problems to fit the sentences. Cards were used to represent items that needed to be listened for in a verbal problem. There were number cards, addition subtraction cards, empty set cards and equal cards. Children arranged the cards to form correct number sentences (Bebout, 1986). Psychological research indicates children's success in solving word problems with concrete representation (Briars & Larkin, 1984; Carpenter & Moser, 1983; Riley, Greeno, & Heller, 1983).

An article in Educational Studies In Mathematics took the opposing view concerning concrete representations, citing vocabulary and syntax influences on children's ability to solve word problems. It appears that children are successful in changing simple verbal problems to concrete, but with more difficult problems, the anticipation of changing words to symbols may be the problem. Examples with unknown sets form the greatest difficulty with concrete representation. "Jim had some toy cars, then Bill gave him four more toy cars. Now Jim has nine toy cars. How many toy cars

did Jim have in the beginning?" Another difficulty arises when the child is given three number sentences for choices and must decide, "What did Joe do?" (Langford, 1986).

Further research was done to see if third graders with differing cognitive abilities solve word problems in different ways. Results showed that these children also use different strategies to solve different problems and have varying success at arriving at the correct answer. The authors suggest that paper and pencil teaching may be inappropriate for young children (Romberg & Collis, 1985).

Methods developed by Talton and Francis (1987) have a central theme which is, "Look at the problem in terms of parts." This helps children to decide on operation to be used. It involves preparation from the concrete, to the semi concrete, to the abstract. "Teachers must engage in verbal exchange to ensure clarity and precision of thought" (Talton, 1987). Using concrete objects students must be taught three steps: combine two or more groups; separate one group into parts; compare two or more groups. Teachers need to model the concrete process. In addition, let children model the process. Then they can choose the operation. Ninety-five percent of all problems are

variations of combine, separate and compare (Talton, 1985). Talton suggested that children draw pictures of the problem. Frequently children do problems by pulling numbers and using them, but not understanding. Math books do not always read in the language children understand. The student should be led to verbalize his/her thought processes to ensure that language is not a barrier. So many problems have implied language that children don't always comprehend. It is suggested, too, that children can rewrite the story problems in their own words to help with comprehension. Children might write original story problems in a learning center that could be kept and exchanged among students over the year. Widespread research has been done, but still has failed to come up with a logical reasoning approach (Talton, 1987).

In conventional instructional approaches, students are first taught to do a particular operation on numbers. This skill is practiced, often for the entire chapter or more in a text book. Then the student is introduced to word problems that require the same operation. In addition they are taught to recognize and use certain key words to identify the needed operation. Sometimes these key words are valid cues to the correct operation and sometimes not. If a student

relies totally on these key words, the student will often be incorrect in choice of operation (Tsai & Derry, 1987).

A research project at San Diego State University concluded that it needed to find out a child's reason for choosing a particular operation on a word problem, rather than computing the answer. The focus needs to be on the child's processing, the way the information is analyzed and synthesized. A child must think to make a decision where story problems are concerned. This is not a given as with a page of simple computational examples (Marshall, 1986).

> Higher-order cognitive skills involved in these problems include making inferences, using related and already known situational information, finding and recognizing analogous items stored in memory, and following logical arguments. At the core of higher-order skills is the ability to understand at a general level what is going on in the item. Included in this level would be recognition of what question is asked, which variables ought to be considered and which are irrelevant, and whether the question is reasonable and logical. A person having this level of understanding should be able to restate the problem in general terms, describing the situation and the probable path to solution (Marshall, 1986, p. 4).

Researchers have come to agreement that there are two stages to solving problems. The first stage is representational, the second is computational (Marshall, 1986). Over time it is hoped the student will come to recognize a similarity among the story

problems the student has been asked to solve. From this it is surmised that the student can build a new memory structure (Marshall, 1986).

In a journal article it was reported that teaching children the use of key words teaches them unreliable tricks. It was concluded that reasoning must be taught. Often students use all the numbers in a word problem, whether or not they are needed. Text books are poorly organized, with the student first learning an isolated skill and then applying that skill. There are few reasoning skills taught in this type of instruction. It is suggested that classroom situations be utilized to make up problems. A series of exercises based on attendance, cost of school lunches, counting items on clothing, or various school supplies, for example, would make arithmetic more relevant. Students can write their own problems in small groups. Give the children some facts, such as pencils are two for 25 cents, erasers are 10 cents, and Billy has one dollar. The children can discuss and then write the problems on small cards. Answers can be placed on the back of the card and used in future lessons (Burns, 1986).

What Burns wrote is repeated again in many articles (Van de Walle, 1987). Let children write their own word problems around real life situations.

Teaching reliance on key words is a mistake.

Allow the students to be creative. Let the child solve the problem his own way, rather than insisting that there is only one way. They may not be ready to understand how it works, but still can creatively come up with an answer.

> Introduce and reinforce (through demonstrations, illustrations, review and constant referral) effective problem solving strategies. Help, not just say read it again. Help them learn how and when to - reword or restate the problem;
> - substitute analogous but simpler quantities;
> - illustrate the problem scenario and relationships by drawing pictures or diagrams;
> - make tables to classify and extend the data given;
> - translate the words into a manipulative situation so that elements can be grouped, moved, sequenced, etc. (Paine, 1984).

In a study in which the mental processes of solving word problems were explored, results were found to have many facets. Competency requires many sub-components, among which are visual or auditory perception, comprehension, decision about operations, translation into a number sentence and transforming the data to a result (Vakali, 1985).

Results of another research report indicate that rewording of word problems makes them easier to understand. Math text writers pay more attention to the

arithmetic aspects of the problems than the wording of the problems. Less able and inexperienced children do better when problems are reworded so that semantics relations are made more clear without altering the mathematical structure of the problem (De Corte, 1985).

A study was made of what strategies are used by first grade students and how these strategies develop. Does problem structure affect the child's solution in simple addition and subtraction problems? Results suggest that since many pre-schoolers are able to solve word problems, why not teach problem solving along with computation rather than as a separate skill (De Corte & Verschaffel, 1987).

Talton (1985) suggested representing word problems with concrete objects. Talton (1987) suggested drawing pictures of word problems. This researcher utilized both of these strategies in the majority of lessons taught.

Burns (1986) and Van de Walle (1987) are strong advocates of having children write their own word problems, thereby using situations relative to them. Many of this researcher's math lessons included students writing math problems on index cards which were later read to the students for solving in subsequent math lessons.

In summary of the research, this writer would like to suggest that word problems are generally not taught utilizing the variety of techniques suggested by the research. It seems evident that utilizing the variety of strategies suggested by the writers referred to in this paper created some new and different mathematical lessons from those previously taught by this researcher and resulting in problem solving skill improvements.

CHAPTER III

Method

The project was implemented with 20 second grade boys and girls midway in the school year. Fifteen minutes per day, three days per week, for 10 weeks were devoted to the project.

The lessons began with the most concrete and terminate with the abstract. Initially a pretest was given. The pretest was composed of problems from the Metropolitan Achievement Test and the (Spring) Achievement Test. The test, consisting of 20 problems, was read by the teacher. Students were not given copies to read along with the teacher on this or any subsequent lessons or tests. The student was required to listen for all information. The results for each student were recorded on a class chart.

The lessons began following the pretest. Each student was given a plastic bag filled with 50 manipulative objects, gathered by the teacher. The bag contained 50 identical objects, but all bags were not the same. Some consisted of plastic chips, some of plastic cubes, some of popsicle sticks. The students did not always use the same manipulatives, and the variety enabled students to share two differing

manipulatives to be able to represent two different objects in a story problem, like chairs and tables for example. The teacher read the problems and then demonstrated the action with a set of manipulatives. The students were required to demonstrate the action of the problem too. The teacher observed the students and was able to assist them in setting up their manipulatives to represent the problem. After one week the students began to make up their own problems, wrote them on index cards, and the teacher read these to students in subsequent lessons. After two weeks of lessons the students were given a test. Students were observed using manipulatives with 10 word problems and were given a check for each one they performed correctly.

Weeks three and four of the lessons concentrated on teaching students to pictorially represent story problems that are read to them. The same format was followed as with the objective above, teacher demonstration, student demonstration, and students writing their own problems. The teacher demonstration consisted of drawing on the chalkboard. The students used pencil and paper at their desks. The teacher helped students as she observed them working. At the end of three and four weeks, the students were tested on their ability to pictorially represent story problems. The

problems were a combination of teacher written and student written. The teacher scored 10 percent for each correct problem.

After testing at the end of week three, course evaluation was conducted by the teacher, using class charts and tests. Students making slower progress were assigned to an aide for identical but smaller group instruction.

The next lessons given during weeks four through eight of implementation taught students to substitute concrete objects with symbols. In addition to the manipulatives described previously, each student was given a set of small pieces of paper, approximately one and one-half inches square printed with numbers, addition, subtraction, equal signs and empty set. The students worked the problems with the manipulatives, then substituted the paper symbol squares. Then the students wrote a number sentence for the problem. The same procedure as with the previous two objectives was followed. The students initially required repeated chalkboard demonstration to understand the concept of all the components of a number sentence. The reminder that every number sentence would have three numbers, a plus or a minus sign and an equal sign required much repetition. This researcher found the repetition

enabled the students to become successful. After each lesson during this four week period, a check list was utilized to indicate students appearing to be making slower progress and to arrange for more individualized instruction with an aide. At the end of eight weeks this skill was tested. The students were read 10 problems. They were given manipulatives and symbol squares of paper. They were required to write complete number sentence. Results from this test indicated students to be given extra help by the aide.

The final two weeks of instruction were somewhat different, in that all concrete objects were taken away. The students were given scratch paper and practiced working with it. They were given only scratch paper on the final test, just as they would on a State Assessment test. During this time the researcher observed students jotting down numbers as they were read. Few students relied on pictorially representing the problem. That step appeared to be something they were able to do in their minds at this point.

At the end of the tenth week, the post test was given, a duplicate of the pretest.

Other than tests, monitoring of progress was done with ongoing observations. A check list was established whereby each student was observed, each

lesson and behavior was recorded to determine if few, many or most students were progressing toward the desired objective. A daily log was kept by this researcher of lessons taught, time frame and general results. The researcher found the results very positive at the end. Of the 20 students in the project, 18 of them raised their scores from the pre to post test from five to 50 points. The two remaining students maintained the same score. On the pretest 14 students scored below 80 percent. On the post test, two students scored below 80 percent. On the post test one child scored 100 percent, three scored 95 percent, nine scored 90 percent, one scored 85 percent, and four students scored 80 percent. Traditionally the students at this school are above average, but these results showed a huge significant skill mastery from pre to post test. The researcher determined from these results that a meaningful rise in scores can be obtained when specific teaching methods are used, such as manipulatives, visualization and listening.

This researcher put intense emphasis on listening skills during all the lessons. Students were told to listen carefully for the numbers as the story problems were read and to quickly jot them down. Students who did this were praised repeatedly. Students were told

to listen for the question the problem asked and were praised for repeating it back to the teacher. Thus a significant effort was made to require careful listening. This was repeated in every lesson during the implementation. The researcher noted that when the students in the practicum project were given the Stanford Achievement Test along with other students, that the practicum students always used scratch paper to solve word problems, while the others did not. It appeared that the training was paying off. In the teaching of all the lessons, dramatics on the part of the teacher played an important part of holding student interest, as did using student written problems. Problems that related to them and their surroundings held the most interest for them.

At the time the researcher was limited to help from an aide to one lesson per week. Many children helped individually showed huge growth. The aide only worked with the children who appeared to be having problems and so the average child was not given that advantage. However given that advantage this researcher feels more students would have scored 95 percent or more on the post test.

Furthermore the children appeared to be enjoying a new type of learning. There were no books, or dittos,

no copying from the board. Instead they had the freedom to play with their manipulatives, draw pictures, write problems, and interact with each other and the instructor.

CHAPTER IV

Results

The results of the practicum were very positive. At the pretest 14 students scored below 80 percent and six students at 80 percent or above. Ten weeks later two students scored below 80 percent and 18 students scored at 80 percent or above. From pre to post test two students stayed the same, one at 60 percent and the other at 80 percent for both tests. Therefore, 90 percent of the students scored at 80 percent or above. The objective was to obtain a score of 80 percent or above for 80 percent of the students.

Throughout the practicum evaluation was done. After two weeks of instruction students were tested on their ability to solve a story problem that was read to them. This test was a false indication of things to come, as 100 percent of the students scored 100 percent. Of course it was easy for them to copy from one another as all manipulatives remained in clear view.

After three weeks a test was given whereby the students had to pictorially represent the word problems. Ten problems were read to the students. They needed only to represent what they heard pictorially.

Drawing ability was not a criteria, for example, a circle could represent a horse if they chose. At this point the objective was that 70 percent of the students would score 60 percent or above. Only 60 percent achieved this score. It appeared to the researcher that listening skills were very weak. At this point half of the students were assigned to the aide for more individualized help. At the end of week four a similar test was given. This time 70 percent of the students scored 60 percent or above. After this test low scoring students were assigned to the aide and those who had improved came back to large group instruction.

At the end of week eight it was time to evaluate the students on their ability to write number sentences. They were allowed to use manipulatives to work out the problems, but the test required them to write complete number sentences. The criteria at this point was that 80 percent of the students would score 80 or above; only 50 percent met that criteria.

Parents at the practicum site are always ready to help their children. When some of them saw the low test scores, they were anxious to help. At conferences with parents it was pointed out that the students must be very careful to listen to and jot down numbers as they are heard and that the problem solving portion of

the Stanford Achievement Test is given in this way. The children practiced listening with parents, the aide and the teacher, and the final results were impressive; 90 percent of the children scored 80 percent or above on the post test. The criteria was that 80 percent would achieve that score.

Comparison of Pre and Post Test Scores

Students	Pretest	Post Test
1	60	60
2	75	85
3	70	80
4	75	80
5	55	90
6	60	75
7	80	95
8	60	95
9	60	95
10	85	100
11	40	90
12	70	90
13	80	90
14	80	90
15	80	80
16	75	80
17	80	90
18	55	90
19	65	90
20	55	90

Overview of Lessons and Tests

Students	Weeks									
	1	2	3	4	5	6	7	8	9	10
1	60 X	100 X	X 0	X 40	X			60		60
2	75 X	100 X	X	X 40	X X	X X	X X	X 80	X X	X 85
3	70 X	100 X	X 0	X 60	X X	X X	X X	X 100	X X	X 80
4	75 X	100 X	X 80	X 60	X X	X X	X X	X 40	X X	X 80
5	55 X	100 X	X 40	X 100	X X	X X	X X	X 80	X X	X 90
6	60 X	100 X	X 60	X 80	X X	X X	X X	X 60	X X	X 75
7	80 X	100 X	X 100	X 100	X X	X X	X X	X 80	X X	X 95
8	60 X	100 X	X 0	X 0	X X	X X	X X	X 100	X X	X 95
9	60 X	100 X	X 60	X 80	X X	X X	X X	X 60	X X	X 95
10	85 X	100 X	X 60	X 80	X X	X X	X X	X 80	X X	X 100
11	40 X	100 X	X 80	X 100	X X	X X	X X	X 60	X X	X 90
12	70 X	100 X	X 100	X 80	X X	X X	X X	X 60	X X	X 90
13	80 X	100 X	X 100	X 60	X X	X X	X X	X A	X X	X 90
14	80 X	100 X	X 60	X 60	X X	X X	X X	60	X X	X 90
15	80 X	100 X	X 60	40	X X	X X	X X	60	X X	X 80
16	75 X	100 X	X 100	X A	X X	X X	X X	X 80	X X	X 80
17	80 X	100 X	X 80	X 60	X X	X X	X X	X 80	X X	X 90
18	55 X	100 X	X A	X 60	X X	X X	X X	X 80	X X	X 90
19	65 X	100 X	X 0	X 100	X X	X X	X X	60	X X	X 90
20	55 X	100 X	X A	X A	X X	X X	X X	X 80	X X	X 90

X = appears to be making progress during lessons

Number is test score in percent

Week 1 Pre Test

Week 10 Post Test

A = Absent

Students' Scores - From Pre to Post Test

Two students stayed the same. Eighteen students improved from five to 50 percentage points.

Up five points	75% - 80%	Student #4
	75% - 80%	Student #16
Up 10 points	75% - 85%	Student #2
	70% - 80%	Student #3
	80% - 90%	Student #13
	80% - 90%	Student #14
	80% - 90%	Student #17
Up 15 points	60% - 75%	Student #6
	80% - 95%	Student #7
	85% - 100%	Student #10
Up 20 points	70% - 90%	Student #12
Up 25 points	65% - 90%	Student #19
up 35 points	55% - 90%	Student #20
	55% - 90%	Student #18
	55% - 90%	Student #5
	60% - 95%	Student #8
	60% - 95%	Student #9
Up 50 points	40% - 90%	Student #11
Same	60% - 60%	Student #1
	80% - 80%	Student #15

CHAPTER V

Recommendations

This researcher will share the knowledge gained from this practicum with colleagues at the target school. Methods and teaching strategies will be shared with the five other second grade teachers at grade level meetings.

This researcher will contact former colleagues at the schools whose test data appear in the Appendices of this practicum and share with them knowledge gained from this practicum. Their test scores are significantly lower than those of the targeted school and so they have the potential for a huge gain.

This researcher will change teaching techniques used prior to this project to incorporate the more successful strategies used in the implementation of the practicum.

A copy of the practicum will be submitted to the Mathematics supervisor for the county.

References

Bebout, Harriet C. "Children's Symbolic Representation of Addition and Subtraction Verbal Problems." Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco, Calif. 1986. ERIC ED 270 320.

Briars, D. N., and Larkin, J. G. "An Integrated Model of Skills in Solving Elementary Word Problems." Cognition and Instruction. 1984, pp. 245-296.

Buchanan, Anne E. "Data Collection Procedures and Descriptive Statistics for the Grade Two (Spring) Achievement Monitoring Tests." Wisconsin Center for Educational Research. 1982. ERIC ED 240 169.

Burns, Marilyn. "Those Pesky Word Problems." Instructor. Nov.-Dec. 1986, pp. 52-54.

Carpenter, T. P., and Moser, J. M. Acquisition of Mathematical Concepts and Processes. New York: Academic Press, 1983.

De Corte, Erik. "Influences of Rewording Verbal Problems on Children's Problem Representations and Solutions." Journal of Educational Psychology. Aug. 1985, pp. 460-470.

De Corte, Erik; Verschaffel, Lieven. "The Effect of Semantic Structure on First Graders' Strategies for Solving Addition and Subtraction Word Problems." Journal for Research in Mathematics Education. Nov. 1987, pp. 363-81.

Langford, Peter E. "Arithmetical Word Problems: Thinking in the Head Versus Thinking on the Table." Educational Studies in Mathematics. May 1986, pp. 193-99.

Marshall, Sandra P. "Understanding Arithmetic Story Problems." One of 46 papers commissioned by the Study Group on the National Assessment of Student Achievement. ERIC ED 279 687.

Paine, Carolyn. "Help Problem Solvers Solve Problems with Problem Solving." Learning. Jan. 1984, pp.

30-31, 33.

Riley, M., Greeno, J., and Heller, J. Development of Children's Problem Solving Ability in Arithmetic. Academic Press, 1983.

Romberg, Thomas A., Collins, Kevin F. "Cognitive Functioning and Performance on Addition and Subtraction Word Problems." Journal for Research in Mathematics Education. Nov. 1985, pp. 375-82.

Talton, C. F. "Supervising Instructional Improvement in the Area of Mathematics Problem Solving." Paper presented to the Florida Association of Mathematics Supervisors. Orlando, Florida. 1985. ERIC ED 287 664.

Talton, Carolyn F.; Francis, Azalia S. "A Thinking Approach to Problem Solving. A Cognitive Scheme for Choosing the Operation in Routine Mathematical Word Problems. Kindergarten Through Grade Eight." Teaching Guide. 1987. ERIC ED 287 664.

Tsai, Chia-jer; Derry, Sharon J. "Application of Schema Theory to the Instruction of Arithmetic Word Problem Solving Skills." Paper presented at the Annual Convention of the Association for Educational Communications and Technology. Atlanta, Georgia. 1987. ERIC ED 285 564.

Vakali, Mary. "Children's Thinking in Arithmetic Word Problem Solving." Journal of Experimental Education. 1985, pp. 106-13.

Van de Walle, John. "Problem Solving Tips For Teachers." Arithmetic Teacher. 1987, pp. 34-35.

Appendices

APPENDIX A

Standardized Test Scores from the Targeted School

STUDENT ACHIEVEMENT

STANFORD ACHIEVEMENT TEST SEVENTH EDITION
APRIL ADMINISTRATION

GRADE	NUMBER TESTED		MEDIAN PERCENTILE										
			READING COMPREHENSION			MATHEMATICS COMPUTATION			MATHEMATICS APPLICATIONS			MATHEMATICS CONCEPTS	
	1986	1987	1986	1987	RES	1986	1987	RES	1986	1987	RES	1986	1987
1	96	107	89	82	16.5	84	78	17.1				83	83
2	89	109	77	81	5.8	88	92	17.1	75	83	4.9	92	87
3	82	105	80	83	7.7	83	85	13.9	85	89	10.8	84	81
4	86	94	76	76	9.3	80	78	4.4	90	81	1.4	88	89
5	99	90	73	80	4.4	92	97	29.9	88	94	20.4	91	NN
6	94	111	81	80	13.7	90	86	10.1	88	85	-1.8	91	NN
ALL GRADES	546	616	79	81	9.3	84	86	15.3	86	88	6.9	90	86

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NOTE FOR EXPLANATORY NOTES AND DATA SOURCES PLEASE SEE PAGE 1

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APPENDIX B

Standardized Test Scores from School B

Grade 1 - 5 Median Percentiles

	Gr. 1 87-88	Gr. 2 87-88	Gr. 3 87-88	Gr. 4 87-88	Gr. 5 87-88
Math Computation	35-48	62-55	32-51	41-39	39-48
Math Applications	N.A.	24-24	26-42	33-24	33-32
Reading Comprehension	35-29	29-29	18-42	21-22	22-24

APPENDIX C

Standardized Test Scores from School C

MATHEMATICS COMPUTATION				
GRADE	DISTRICT 1987	SCHOOL C 1987	DISTRICT 1988	SCHOOL C 1988
1	49	73	49	78
2	66	65	62	71
3	56	71	56	59
4	53	47	54	68
5	58	57	57	51
6	63	72	60	81

MATHEMATICS APPLICATION				
GRADE	DISTRICT 1987	SCHOOL C 1987	DISTRICT 1988	SCHOOL C 1988
1	--	--	--	--
2	46	46	46	67
3	54	63	57	61
4	51	51	55	66
5	54	58	52	45
6	54	59	52	68

APPENDIX D

Standardized Test Scores from School D

	STANFORD ACHIEVEMENT TEST					
GRADE	READING COMPREHENSION		MATHEMATICS COMPUTATION		MATHEMATICS APPLICATIONS	
	1987	1988	1987	1988	1987	1988
Grade 1	36	30	40	39	--	--
Grade 2	42	48	66	78	51	50
Grade 3	46	52	38	69	65	65
Grade 4	34	40	54	44	49	48
Grade 5	33	46	48	62	52	47
Grade 6	39	45	60	72	56	50

APPENDIX E

Pre and Post Test Page 1

E Row E. I am going to read a number story about toy airplanes. I will read the story twice. Listen both times before you mark a box. David has 9 toy airplanes. His sister Nancy has 13 toy airplanes. How many more toy airplanes does Nancy have than David? (Repeat. Allow time for the children to figure out their answers to rows E-H.)

F Row F. This number story is about bottle caps. For this story you may write on the paper if you want to. Tom has 24 old bottle caps. He also has 57 new bottle caps. How many bottle caps does Tom have all together? (Repeat. If necessary, remind the children to "make an X" on their answer.)

G Row G. This number story is about shells. 17 shells are in a box. Some shells are little. 8 are big. How many little shells are in the box? (Repeat.)

H Row H. This number story is about soccer. For this story you may write on the paper if you want to. There were some soccer players on the field. 23 more players came. Now there are 35 players on the field. How many players were on the field at first? (Repeat. "Make an X.")

Turn to the next page.

Page 2

K Row K. Look at the number sentences. One of the number sentences tells how to find the answer for this story about hats. After I read the story, make an X on the number sentence that tells how to find the answer. Karla had 15 hats. She gave 9 hats to Steve. How many hats did Karla have left? (Repeat.)

L Row L. This number story is about stickers. Make an X on the number sentence that tells how to find the answer. Sarah has 28 stickers. Her brother Ricky has 34 stickers. How many more stickers does Ricky have than Sarah? (Repeat.)

M Row M. This number story is about things to drink. There are 11 glasses on the table. 5 have orange juice in them. The rest have milk in them. How many glasses have milk in them? (Repeat.)

N Row N. This number story is about children swimming. There were 46 children swimming in the pool. 27 more children jumped into the pool. How many children were in the pool then? (Repeat.)

Page 3

Now we will do some different work. I will read a number story to you. Then I want you to write a number sentence for the story. You don't need to solve the sentence. Just write the sentence the best you can without solving it. Write it on the line.

STORY A Jenny had 13 balloons. She gave 9 balloons to Ben. How many balloons did Jenny have left? (Repeat.)

STORY B Mark has 16 crayons. His sister Pam has 58 crayons. How many more crayons does Pam have than Mark? (Repeat.)

STORY C Jean had 26 bottle caps. Her mother gave her 37 more bottle caps. How many bottle caps did Jean have all together? (Repeat)

STORY D There are 11 trucks in the sandbox. 8 are big and the rest are little. How many little trucks are in the sandbox? (Repeat.)

Page 4

M. Move to the box with the two leaves. We had eight toy cars. Mother bought us 2 more. How many did we have then? (Repeat.)

N. Move down to the box with the one toothbrush. Paula found 6 baby birds in a nest. Three of them flew away. How many birds were left? (Repeat.)

O. Move down to the box with two toothbrushes. We scored 9 points in one game and 7 points in another. How many points is that in all? (Repeat.)

P. Move down to the box with the pencil. 13 boys were playing a game. Seven went home. How many boys were left? (Repeat.)

Page 5

K Row K. Look at the number sentences. One of the number sentences tells how to find the answer for this story about keys. After I read the story, make an X on the number sentence that tells how to find the answer. Sally has 8 keys. Her brother Mike has 14 keys. How many more keys does Mike have than Sally? (Repeat.)

L Row L. This number story is about beads. After I read the story, make an X on the number sentence that tells how to find the answer. Jack has 16 red beads. He also has 56 green beads. How many beads does Jack have all together? (Repeat.)

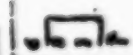
M Row M. This number story is about links. Mark the number sentence that tells how to find the answer. Patty made a chain of links. She used 3 links first. Then she used 8 more links. How many links long is her chain? (Repeat.)

N Row N. This number story is about marbles. On Tuesday Melinda won 31 marbles. On Wednesday she won some more marbles. She won 64 marbles all together. How many marbles did she win on Wednesday? (Repeat.)

Name

Date

Solving Word Problems
46

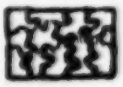
E.	4	13	5	7
F.	33	73	81	54
G.	25	17	9	22
H. 	12	23	58	10

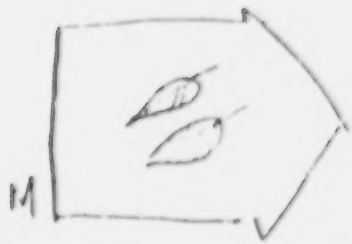
K	15+9=□	15-9=□	9-6=□	15-6=□
L	28+34=□	34+6=□	34-28=□	34-6=□
M	11+5=□	11+6=□	11-5=□	5+6=□
N	46-27=□	46+27=□	61+27=□	46+6=□

A

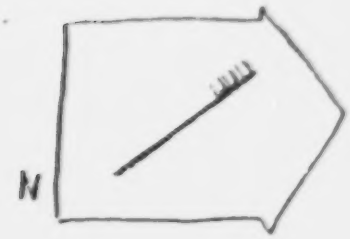
B

C

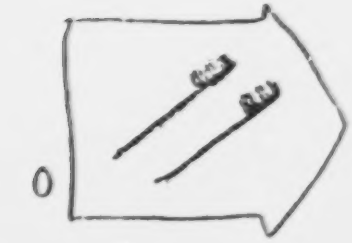
D 



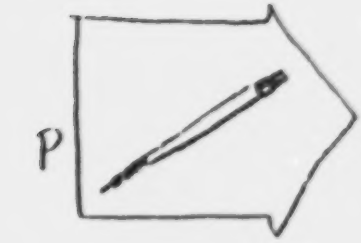
M 8 10 11 12



N 3 2 8 9



O 15 16 17 18



P 6 7 8 10

page 5

K

14+8=□	14-8=□	14+6=□	8+14=□

L

72+56=□	56-16=□	16+56=□	56-16=□

M

8+8=□	8-3=□	3+8=□	8-8=□

N

64=□	64-31=□	31+64=□	64-6=□